TOP GEAR

These days it seems virtually impossible for a manufacturer to release a new tractor unit without giving it a new rear (drive) axle as well. Lucy Radley examines why operators should care about axle ratios

There are two main levers for reducing fuel consumption and, hence, carbon emissions. First there's downsizing, so reducing the physical size of the engine used to do the job. Then there's downspeeding. "The thing that's making us talk about axle ratios is that we're downspeeding our engines at the heavier end of the truck range," explains Bob Gowans, product and sales technical manager at Mercedes-Benz Trucks. "As time's gone on we're changing the injection systems to make them run cleaner, and at the same time bringing the usable torque down the rev range." Where, traditionally, peak torque was at round 1,300rpm, now it's at 1,000-1,100rpm, or even lower. Fewer revs means less fuel consumed. With this has come a very flat torque curve, which means engines can pull a long way down before needing a gear change.

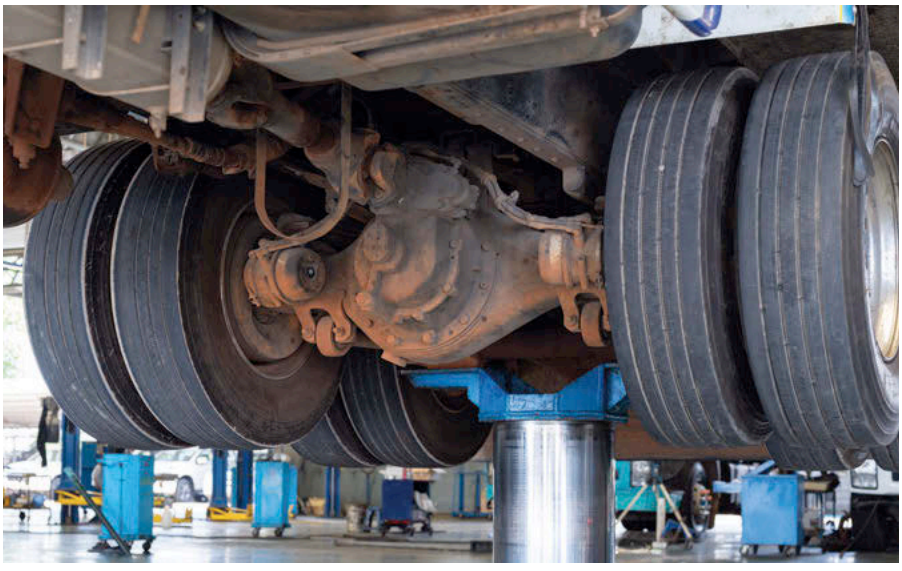
"The reason we're doing this is because we want to boost the efficiency of the engine," Gowans continues. "One of the things that stops us doing that is the internal friction in the engine – churning the oil, turning the bearings against each other – and that friction goes up with the square of the engine speed." In other words, if you turn an engine twice as fast, you don't lose twice, but four times as much energy through friction.

SPEED AND TORQUE

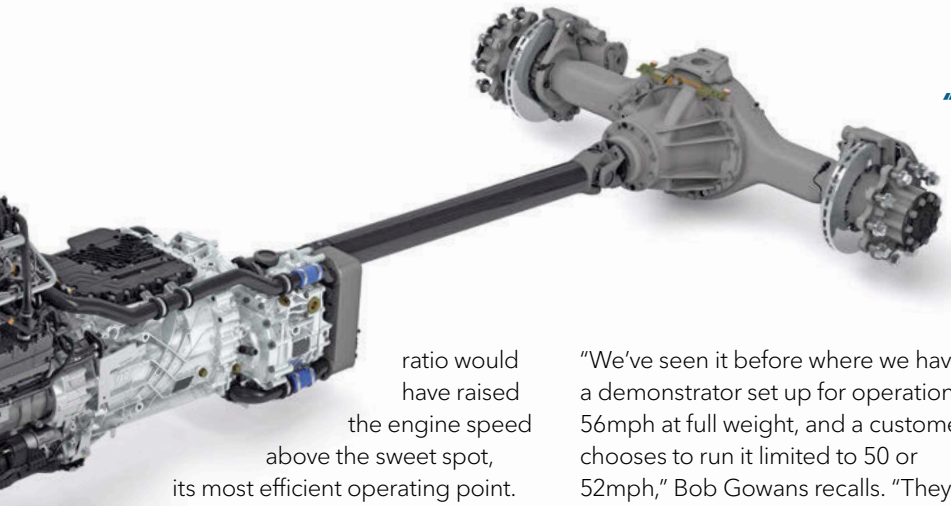
Downspeeding affects drivetrain gear ratios since speed and torque are linked. "To get the same power out, we need our wheels to keep turning at the same speed," Gowan reminds us. "So we need an axle ratio – or gearbox ratio – between the two which is lower." Lower gears offer less revs but higher torque; higher gears do the opposite.

There are other factors at play here too, not least the sea change in standard tyre sizes fitted to long haul vehicles across Europe from 295/80 R22.5 to a more fuel-efficient 315/70 with less sidewall flex. The latter are 3% – 31mm – smaller in diameter, so have a smaller circumference, which means that they revolve about 3% more in every km. "Putting on a smaller tyre gives you the same problem as downspeeding the engine," he says. "So in order to get the most out of it we need to speed it down again." In Gowans' time with Mercedes-Benz, he's seen standard drive axle ratios go from 2.846:1 in the Actros MP3 down to 2.733, 2.611 and now 2.412 in the latest model.

Other manufacturers are doing the same. "In 2009, at Euro V, our mid-range D26 12.4-litre engine developed 434bhp and 2,100Nm of torque at 1,000rpm," recalls Nick Handy, head of product management at MAN Trucks. "So to get an optimum driveline with 315/70 tyres, the differential ratio we offered at the time was 2.85:1." Then engine technology moved on, and initially at Euro VI that engine produced the same torque but at 930rpm. Handy points out that it had to reduce the diff ratio in turn, to 2.71:1, because using the previous



© KissShot - stock.adobe.com



"Choosing the right axle ratio can make the difference between a truck that does what you want it to, and one that doesn't"
Phil Moon

ratio would have raised the engine speed above the sweet spot, its most efficient operating point. This trend has carried on through Euro VI-c and led to a 2.53:1 diff ratio, until finally today, where the Euro VI-d version of MAN's D26 produces 464bhp and 2,400Nm of torque, so is offered in its New Truck Generation long-haul tractors with a 2.31:1 rear axle (assemblies from other models pictured below).

IMPORTANT

"Choosing the optimum rear axle ratio has always been important," agrees Phil Moon, marketing manager at DAF Trucks. Downspeeding the MX-11 and MX-13 engines, along with changing ratios in the rear axle, make up a large part of the 7% improvement in fuel economy the latest DAFs are delivering over previous engines, with the help of the ZF TraXon transmission. (MX-13 driveline shown above). "This is more responsive, delivering super-quick downshifts to maintain speeds on hills, while a wider ratio spread ensures good control for precision low-speed manoeuvring."

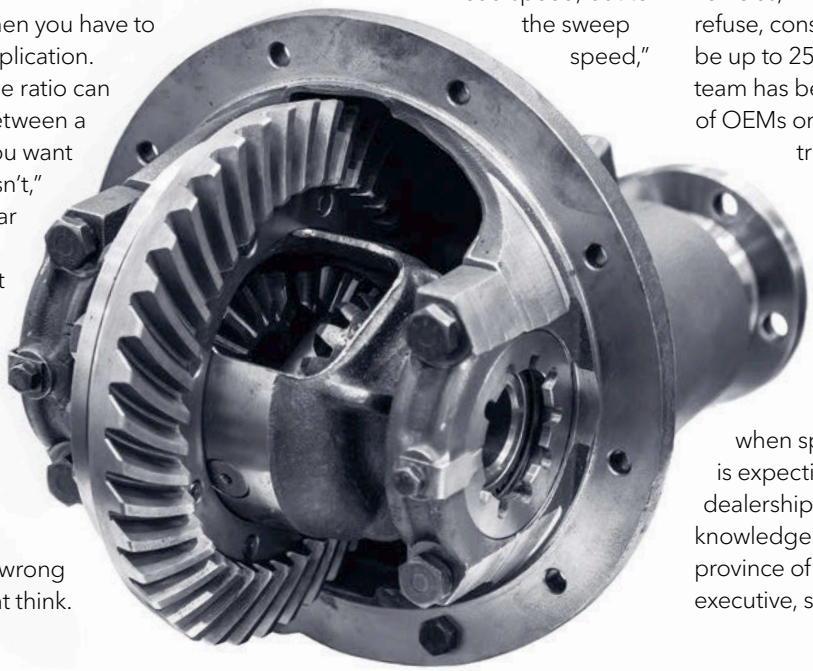
All great stuff, but then you have to start thinking about application. "Choosing the right axle ratio can make the difference between a truck that does what you want it to, and one that doesn't," Moon reminds us. "Gear a driveline too tall, and the vehicle may feel flat and unresponsive and the gearbox may not hold top gear. Gear it too low, and you may miss out on fuel savings by making the engine rev higher than it needs to."

Getting that last bit wrong is easier than one might think. "We've seen it before where we have a demonstrator set up for operation at 56mph at full weight, and a customer chooses to run it limited to 50 or 52mph," Bob Gowans recalls. "They won't then sit in top gear, so the fuel consumption ends up being worse because they're going slower. That's not to say running slower doesn't save fuel, only that the truck needs the right driveline setup to make the most of it. So if your normal road speed is going to be lower, you need to consider where the sweet spot – the 'green band' in old terminology – is for that particular operation."

OTHER VEHICLES

For tippers, that means slightly lower gearing to offer better gradeability, Nick Handy points out. Heavy haulage trucks habitually running at 50mph are a similar case. "If you've got 150 tonnes – and there is even a 250-tonner in our product line – the diff ratio is much shorter, to maximise torque at those lower road speeds."

Then there are even more specialist vehicles. "When we spec up roadsweepers, they're geared not to the road speed, but to the sweep speed," Handy explains. "So you might put a 5.29:1 diff in an 18-tonne sweeper, which is very, very shallow. You'd never put that in a regular 18-tonne rigid because the top speed would be uneconomic, but then a sweeper should spend most of its life sweeping."



It's not just the OEMs themselves who have an interest in the municipal sector. "There is much head scratching about how the industry will achieve the first EU CO_2 regulation deadline announced in 2019 (15% CO_2 reduction by 2025) using current, conventional technology," contends Ashley Brooks, UK and ROI area manager at Allison Transmissions.

"To reduce emissions and improve fuel economy further, industry engineers and scientists are going to have to do something fundamentally different, like looking at drive axle designs, configurations and axle ratios, combined with other technologies."

"Trucks working around towns and in the countryside, which face adverse gradients or topography, benefit from having a different axle ratio to a truck that works predominantly on motorways," Brooks continues. "The steepest gradients faced by these vehicles, which typically are working in refuse, construction and distribution, can be up to 25%." Allison Transmission's UK team has been working with a number of OEMs on rear axle optimisation trials. These have reported good potential fuel and environmental savings, particularly for refuse customers.

Ultimately, the important thing from the fleet operator's point of view is to ask for guidance when speccing a vehicle. No one is expecting buyers to turn up at a dealership already armed with detailed knowledge on this subject; this is the province of the trained truck sales executive, stresses MAN's Nick Handy. TE